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Development of a Fatigue Risk Management System for the Canadian Aviation Industry

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Development of a Fatigue Risk Management System for the Canadian Aviation Industry

by
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16. Abstract

This report details the work done in the development of a fatigue risk management system (FRMS) for the Canadian aviation industry. This performance-based system aims to reduce fatigue-related errors and provide more flexibility for operators in the way they deal with these risks.

Work focused on the development of an FRMS toolbox. The key elements of the toolbox are policy and procedures guidelines to tailor the FRMS to specific operational requirements, competency-based training and education materials, and audit methodologies to identify both risk level and whether interventions have been successful in reducing risk.

Extensive industry consultation was undertaken to ensure the FRMS toolbox would meet the needs of operators. Feedback from stakeholders was taken into consideration throughout the development of the toolbox and is also reflected in the recommendations for FRMS policy, implementation and assessment.

Stakeholders believe that considerable assistance from Transport Canada will be required to effectively implement an FRMS. Cultural change, particularly at the individual level, also remains a significant obstacle to FRMS acceptance. However, with sufficient preparedness and strong communication, the aviation industry and Transport Canada should be able to overcome these hurdles and work collaboratively to better manage fatigue-related risk.

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16. Résumé

Ce rapport présente les travaux réalisés en marge de l'élaboration d'un système de gestion des risques liés à la fatigue (SGRF) pour le milieu aéronautique canadien. Ce système axé sur les performances vise à réduire les erreurs causées par la fatigue et à donner aux exploitants plus de souplesse dans la façon d'affronter ces risques.

Les travaux ont porté sur l'élaboration d'une boîte à outils SGRF. Les éléments clés de cette boîte à outils sont des lignes directrices pour l'élaboration de politiques et de procédures SGRF adaptées à des besoins opérationnels particuliers, une formation axée sur les compétences et du matériel éducatif, et des méthodes de vérification pour déterminer, d'une part, le niveau de risque et, d'autre part, si les interventions destinées à atténuer le risque ont atteint leur but.

De vastes consultations ont été menées auprès de l'industrie, afin que le SGRF soit au plus près des besoins des exploitants. Les réactions des parties intéressées ont été prises en considération à toutes les étapes de l'élaboration de la boîte à outils. Elles ont aussi fortement inspiré les recommandations touchant les politiques, la mise en œuvre et l'évaluation d'un SGRF.

Selon les parties intéressées, une mise en œuvre efficace d'un SGRF nécessitera une aide considérable de la part de Transports Canada. Par ailleurs, le changement de culture nécessaire à l'acceptation des SGRF, notamment à l'échelle individuelle, demeure un obstacle important. Toutefois, moyennant une préparation suffisante et des communications assidues, le milieu aéronautique et Transports Canada devraient être capables de surmonter ces obstacles et de travailler ensemble à une meilleure gestion des risques liés à la fatigue.

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EXECUTIVE SUMMARY

The reality of fatigue-related risk is clearly recognized by the Canadian aviation industry. To better manage fatigue and help mitigate this risk, Transport Canada has developed a performance-based Fatigue Risk Management System (FRMS) for maintenance and flight operations.

The FRMS covers aviation maintenance engineers (AME), whose jobs involve a high level of shift work, but are not covered by the current prescriptive limitations on flight and duty hours for flight operations. It could also be considered as an alternative system in flight operations for those operators applying for an exemption to the flight and duty time regulations. In this context, certificate holders would present a "safety case" to Transport Canada, stating their operational needs and how they intend to manage fatigue-related risk. In this way, individual operators can design rules for an FRMS to suit their own operation, thereby allowing a higher level of flexibility than prescriptive duty limitations. As such, rather than prescribing a single set of rules that must be followed by all, Transport Canada could mandate the requirement of an approved FRMS.

To increase consistency of FRMS standards across the industry and reduce development costs for each organization, Transport Canada contracted edu.au to develop an FRMS toolbox for aviation maintenance and aircraft operators. The key elements of the toolbox include three main components: a policy builder to tailor the FRMS to specific operational requirements; competency-based training and education materials; and audit methodologies to identify both risk level and whether interventions have been successful in reducing risk.

To ensure an FRMS toolbox that would work well for industry, focus groups were organized with participants from 13 aviation organizations across Canada. The groups represented small, medium, and large operations in a variety of areas such as airlines, charters, and medevac and helicopter operations. Representatives included senior management, chief pilots, persons responsible for maintenance (PRMs), AMEs, pilots, schedulers, occupational health and safety representatives, human factors personnel, and union delegates.

The focus group participants were asked questions about fatigue management and whether it should be regulated, FRMS implementation, policy templates, FRMS templates, and training and education. The general concepts behind the FRMS were well accepted by focus group participants. In particular, stakeholders believed that an FRMS would improve operational flexibility, increase general awareness of the risks of fatigue, and provide a sensible and flexible approach to fatigue risk management that is both tailored to the organizational risk profile and scientifically defensible.

Operators thought it would be useful for Transport Canada to provide policy templates with sections that can be tailored and clear examples of how to do this. They would also like Transport Canada to develop an organizational-level scheduling/assessment program, risk management guidelines for determining organizational-level scheduling benchmarks, individual-level scheduling/assessment systems, guidelines and decision trees for applying the individual-level scheduling/assessment system, and competency and web-based training and education. As a whole, those consulted were supportive of the development of a public domain FRMS toolbox. They indicated that the provision of

tools and templates would significantly reduce the cost of FRMS development and implementation.

While the overall outlook at the conceptual level was positive, some concern was raised as to how an FRMS would work in reality when applied to industry. The negative feedback was largely related to concerns over how Transport Canada would develop and implement this project at the industry level and the workload associated with compliance. Operators were concerned about the costs related to FRMS implementation and training, the administrative burden, the lack of existing examples of implementation, and the ability of organizations to effectively manage the individual-level scheduling/ assessment system.

As a result of the feedback from the focus groups, an FRMS toolbox was developed that includes:

- Effective FRMS policy development strategies, including clear descriptions of policy requirements, how to tailor the policy to meet specific operational needs, and examples of different FRMS policies
- An organizational-level scheduling/assessment program (i.e. fatigue audit tools) that can be incorporated into current scheduling systems
- Risk management guidelines for determining organizational-level scheduling benchmarks
- Individual-level scheduling/assessment systems
- Guidelines and decision trees for applying the individual-level scheduling/ assessment system
- Competency and web-based training and education

The FRMS toolbox will be available online from Transport Canada's website at www.tc.gc.ca.

To further address industry concerns and ensure a smooth implementation process, an FRMS will be field tested with a Canadian airline. This trial will enable Transport Canada to closely monitor the progress of the FRMS, observe how it is received by industry, and refine the system in the early stages before wide-scale implementation. From an industry perspective, this process will allow organizations to see the benefits of implementing an FRMS and gain insight from the lessons learned during the trial. Ultimately, field testing should result in minimizing the cost and increasing the efficiency of FRMS implementation for both Transport Canada and the operator.

Based on focus group interviews, it would appear that industry is prepared to work with Transport Canada to better manage fatigue-related risk. However, stakeholders believe that significant assistance from Transport Canada will be required to do this effectively. Therefore, in addition to what has already been developed, several additional issues should be considered:

- **Preparedness** – Transport Canada inspectors should be trained and educated in FRMS and skilled at assessing FRMS proposals.
- **Cultural Change** – due to the significant culture change required for FRMS acceptance, particularly at the individual level of responsibility, an FRMS should be implemented progressively to ensure that sufficient time is provided for

training and education to occur at various levels of industry. This would greatly enhance the acceptability and operational application of the FRMS and allow Transport Canada to ensure that the appropriate resources are in place to assess and accept the FRMS applications.

- **Communication** – information sharing should expedite the cultural change needed for industry to embrace effective fatigue risk management practices. "Lessons learned" should be continually fed back to industry through regulatory safety bulletins or website links.
- **Fairness** – the issue of maintaining a level playing field should be addressed by establishing standard practices in the initial stages of FRMS implementation. An effective way of achieving this is to control the assessment of the first few trial FRMS implementations from a centralized unit within Transport Canada. Once the standards of assessment are established, the assessment and approval procedures can then be moved to the regional inspectors.
- **Evaluation** – the FRMS should be seen as an evolving system that will constantly improve as the industry gains more experience. Transport Canada should conduct a large-scale evaluation within two years of wide-scale FRMS implementation and every five years thereafter.
- **Collaboration** – with fatigue risk management becoming common practice throughout the industrialized world, Transport Canada should collaborate with other regulators undertaking similar trials to share implementation and best-practice experiences.

SOMMAIRE

Le milieu aéronautique canadien reconnaît d'emblée la réalité des risques liés à la fatigue. Pour mieux gérer la fatigue et contribuer à atténuer les risques qu'elle représente, Transports Canada a élaboré un Système de gestion des risques liés à la fatigue (SGRF) pour les services d'entretien d'aéronefs et les compagnies aériennes.

Le SGRF vise les techniciens d'entretien d'aéronefs (TEA), dont le travail s'effectue beaucoup par quarts, mais qui ne sont pas assujettis aux limites d'heures de vol et d'heures de service qui régissent les opérations aériennes. Même dans le secteur des opérations aériennes, le SGRF pourrait être considéré comme un système de rechange aux règles sur les heures de vol et les heures de service, pour les exploitants qui demanderaient à être exemptés de celles-ci. Le titulaire de certificat aurait à présenter un «dossier de sécurité» à Transports Canada, dans lequel il énoncerait ses besoins opérationnels et la manière dont il entend gérer les risques liés à la fatigue. Chaque exploitant pourrait ainsi adapter les règles de son SGRF à sa situation propre et bénéficier d'une plus grande souplesse qu'avec les limites prescriptives d'heures de service. En bref, plutôt que de prescrire un seul ensemble de règles applicables à tous, Transports Canada exigerait de chaque exploitant qu'il applique un SGRF préalablement approuvé.

Pour favoriser la cohérence des normes du SGRF à la grandeur de l'industrie, et pour réduire les coûts que devrait assumer chaque entreprise pour l'élaboration de son système, Transports Canada a confié à edu.au la tâche d'élaborer une boîte à outils SGRF pour les services d'entretien d'aéronefs et les exploitants aériens. Cette boîte à outils comprend trois éléments clés : lignes directrices pour l'élaboration de politiques et de procédures SGRF adaptées à des besoins opérationnels particuliers; formation axée sur les compétences et matériel éducatif; méthodes de vérification pour déterminer, d'une part, le niveau de risque et, d'autre part, si les interventions destinées à atténuer le risque ont atteint leur but.

Pour avoir l'assurance que la boîte à outils SGRF allait être utile à l'industrie, des groupes de discussion ont été organisés, qui réunissaient des représentants de 13 entreprises aéronautiques du Canada. Il s'agissait de petites, moyennes et grandes entreprises œuvrant dans divers domaines du milieu aéronautique : compagnies aériennes, exploitants de vols nolisés, services d'évacuation sanitaire, services d'hélicoptères. Au nombre des participants se trouvaient des cadres supérieurs, des chefs pilotes, des personnes responsables de l'entretien, des TEA, des pilotes, des préposés aux horaires, des représentants de la santé et de la sécurité au travail, des spécialistes des facteurs humains et des délégués syndicaux.

Les questions soumises aux participants portaient sur la gestion de la fatigue et la pertinence de réglementer celle-ci, la mise en œuvre d'un SGRF, les canevas de politiques, les modèles de SGRF, et la formation et l'éducation. Les grands concepts qui sous-tendent le SGRF ont reçu un bon accueil dans les groupes de discussion. Les participants estimaient notamment qu'un SGRF pouvait accroître la souplesse opérationnelle, améliorer la connaissance générale des risques liés à la fatigue, et constituer une démarche raisonnable et souple pour la gestion des risques liés à la fatigue, à la fois alignée sur le profil de risque de l'entreprise et scientifiquement défendable.

Les exploitants ont émis l'opinion qu'il serait bon que Transports Canada fournisse des canevas de politiques, avec sections à moduler, assortis d'exemples clairs de modulations. Ils souhaitent en outre que Transports Canada élabore un programme d'établissement/évaluation des horaires à l'échelle de l'organisation, des lignes directrices sur la gestion des risques, afin de définir des repères pour l'établissement des horaires à l'échelle de l'organisation, des systèmes d'établissement/évaluation des horaires à l'échelle individuelle, des lignes directrices et des arbres de décision pour appliquer le système d'établissement/évaluation des horaires à l'échelle individuelle, et des outils de formation et d'éducation axées sur les compétences utilisant le Web. Globalement, les personnes consultées étaient d'accord pour que la boîte à outils SGRF soit versée dans le domaine public. Elles ont indiqué que la fourniture d'outils et de modèles allait réduire de beaucoup les coûts d'élaboration et de mise en œuvre d'un SGRF.

Globalement et sur le plan conceptuel, le SGRF a été accueilli de façon positive. Mais des doutes ont été exprimés quant au fonctionnement concret d'un SGRF dans l'industrie. Les commentaires négatifs tenaient beaucoup à des inquiétudes à l'égard de la façon dont Transports Canada s'y prendrait pour élaborer et mettre en œuvre le projet à la grandeur de l'industrie, et à l'égard de la charge de travail associée à la vérification de la conformité. Les exploitants se sont dits préoccupés par les coûts de mise en œuvre du SGRF et de formation connexe, le fardeau administratif et l'absence d'exemples concrets de mise en œuvre, et doutaient de la capacité des entreprises de gérer effectivement le système d'établissement/évaluation des horaires à l'échelle individuelle.

Les commentaires exprimés dans les groupes de discussion ont servi de balises pour l'élaboration d'une boîte à outils SGRF qui contient ce qui suit :

- Des stratégies pour l'élaboration de politiques de SGRF efficaces, y compris une description claire des exigences liées aux politiques, des conseils sur l'adaptation des politiques pour qu'elles répondent à des besoins opérationnels particuliers, et des exemples de différentes politiques de SGRF
- Un programme d'établissement/évaluation des horaires à l'échelle de l'organisation (c.-à-d. des outils de vérification de la fatigue) pouvant être incorporé aux systèmes actuels d'établissement des horaires
- Des lignes directrices sur la gestion des risques afin de définir des repères pour l'établissement des horaires à l'échelle de l'organisation
- Des systèmes d'établissement/évaluation des horaires à l'échelle individuelle
- Des lignes directrices et des arbres de décision pour appliquer le système d'établissement/évaluation des horaires à l'échelle individuelle
- Un programme de formation et d'éducation axées sur les compétences, utilisant le Web

La boîte à outils SGRF sera disponible en ligne sur le site Web de Transports Canada à l'adresse suivante : www.tc.gc.ca.

Pour répondre aux préoccupations que pourrait encore avoir l'industrie, et pour assurer un passage en douceur à la phase de mise en œuvre, un SGRF sera mis à l'essai en service réel, dans une compagnie aérienne du Canada. Cet essai permettra à Transports Canada de suivre de près la mise en place du SGRF, d'observer la façon

dont il sera accueilli par l'industrie, et de perfectionner le système avant qu'il soit mis en œuvre à grande échelle. Par ailleurs, cette démarche prudente permettra aux organisations de constater les avantages qu'elles peuvent tirer de la mise en œuvre d'un SGRF et de profiter des «leçons apprises» pendant l'essai. À terme, l'essai en service réel devrait réduire le coût et accroître l'efficacité de la mise en œuvre d'un SGRF, tant pour Transports Canada que pour l'exploitant.

Selon les commentaires exprimés lors des groupes de discussion, l'industrie semblerait disposée à travailler de concert avec Transports Canada pour mieux gérer les risques liés à la fatigue. Mais cela n'ira pas sans une aide substantielle de Transports Canada, estiment aussi les parties intéressées. Ainsi, outre les documents élaborés à ce jour, il reste encore plusieurs questions à examiner:

- **Préparation** – les inspecteurs de Transports Canada devraient recevoir une formation sur les SGRF et être qualifiés pour évaluer des propositions de SGRF.
- **Changement de culture** – en raison de l'important changement de culture nécessaire à l'acceptation d'un SGRF, en particulier au niveau de responsabilité individuel, tout SGRF devrait être mis en œuvre progressivement, pour que l'on ait le temps d'assurer la formation et l'éducation du personnel. Cela favoriserait grandement l'acceptation et l'application du SGRF, et permettrait à Transports Canada de mettre en place les ressources nécessaires pour évaluer et accepter les applications SGRF.
- **Communications** – le partage d'information devrait faciliter le changement de culture nécessaire pour que l'industrie adopte des pratiques de gestion efficace des risques liés à la fatigue. Les «leçons apprises» devraient être transmises en continu à l'industrie, par les bulletins de sécurité publiés par les organismes de réglementation ou des liens vers des sites Web.
- **Équité** – pour que les règles du jeu soient équitables, il faudra établir des normes d'évaluation dès les premières étapes de la mise en œuvre d'un SGRF. Une manière efficace d'y arriver est de procéder à l'évaluation des premiers essais de mise en œuvre d'un SGRF depuis un service centralisé au sein de Transports Canada. Une fois les normes d'évaluation établies, les procédures d'évaluation et d'approbation pourront être transférées aux inspecteurs régionaux.
- **Évaluation** – le SGRF doit être considéré comme un système évolutif, qui s'améliorera constamment à mesure que l'industrie acquerra de l'expérience. Transports Canada devrait mener une évaluation à grande échelle dans les deux ans suivant la mise en œuvre généralisée des SGRF, et tous les cinq ans par la suite.
- **Collaboration** – la gestion des risques liés à la fatigue devenant pratique courante à la grandeur du monde industrialisé, Transports Canada devrait partager avec les autres organismes de réglementation engagés dans des essais semblables ses expériences en matière de mise en œuvre et de meilleures pratiques.

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GLOSSARY

AME	Aviation Maintenance Engineer
CARAC	Civil Aviation Regulatory Advisory Council
CARs	Canadian Aviation Regulations
FAID	Fatigue Audit InterDyne: Software used to estimate work-related fatigue caused by a work schedule
FRMS	Fatigue Risk Management System
PIM	Person In-charge of Maintenance
SATOPS	Safety of Air Taxi Operations
SMS	Safety Management System

1. INTRODUCTION

Fatigue is recognized as a significant risk in operations involving extended working hours. In Canadian aviation flight operations, fatigue has traditionally been regulated through prescriptive limitations on flight and duty hours. However, Canadian Aviation Maintenance Engineers (AME), whose jobs involve a high level of night shift work, remain unregulated with regard to fatigue management.

In 1996, Transport Canada was instructed by the Safety of Air Taxi Operations (SATOPS) to determine: (a) whether there was a need to regulate AME duty times, and (b) appropriate limitations thereof. Consequently, Transport Canada commissioned a study on hours of work in the civil aviation maintenance environment. In short, the report[1] indicated that fatigue and excessive periods of work may be present in the AME workforce. Therefore, efforts should be made to determine an appropriate level of duty limitations and regulation.

In 2002, the Civil Aviation Regulatory Advisory Council (CARAC: Part V Technical Committee) met to discuss methods of addressing the risk of fatigue. There was a clear consensus that the prescriptive duty limitations approach used in flight operations was not a viable solution. An alternate performance-based approach was suggested, which would fit within the larger scope of safety management systems being implemented in the Canadian aviation industry. Many aircraft operators also saw the concept of moving away from prescriptive duty limits to a performance-based approach as favourable. Therefore, Transport Canada's focus for the current project was on the development of a performance-based Fatigue Risk Management System (FRMS) that could encompass both maintenance and aircraft operator roles.

Within the performance-based approach, licensed operators are required to present a "safety case" to the regulator (Transport Canada), stating their operational needs and how they intend to manage fatigue-related risk. In this way, individual operators can design rules for an FRMS to suit the size and complexity of their own operation, thereby allowing a higher level of flexibility than prescriptive duty limitations. As such, rather than prescribing a single set of rules that must be followed by all, Transport Canada could mandate the requirement for approved operators to implement an FRMS. In aviation operations, the FRMS would be considered as an alternative system for those operators applying for an exemption to the flight and duty time regulations.

Many of the CARAC participants were attracted by the non-prescriptive approach to fatigue management. However, others were concerned by the potential lack of clarity, which could conceivably result in inconsistent enforcement. There was also concern about the potential for excessive development costs of the system.

This concern was further compounded by research done in Australia indicating that one of the principal barriers to implementing an FRMS was the absence of an approved framework for industry members to build a safety case for the regulator. In particular, the lack of pre-existing policy documents, training and educational materials and audit

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[1] Rhodes, Wayne. (2001). *Assessment of Aircraft Maintenance Engineers (AMEs) Hours of Work: Phase 1.* Montreal: Transportation Development Centre of Transport Canada. (www.tc.gc.ca/tdc/publication/pdf/13800/13875e.pdf).

methodologies had resulted in unnecessary duplication of materials and significantly increased development costs to the industry as a whole.[2]

To improve consistency of FRMS standards across the industry and reduce development costs for each organization, the development of a public domain fatigue management "toolbox' was proposed. The toolbox would include a set of FRMS methodologies such as policy guidelines, training materials, and other tools that approved maintenance and aircraft operators could use to develop an FRMS that meets their specific operational needs. Furthermore, it would assure the regulator that the approved operators were managing fatigue-related risks appropriately.

In August 2003, Transport Canada contracted edu.au to develop an FRMS toolbox for aviation maintenance and aircraft operators. The key elements of the toolbox include three main components:

- A policy builder to tailor the FRMS to specific operational requirements. The policy builder is structured to fit within a larger safety management system (SMS), and consists of:
    - Guidance notes – an explanation of why specific policy sections are important, and which operational aspects they should focus on
    - Points to consider – questions to help tailor the content specifically to operational needs
    - Sample text – an example of the phrasing that could be used within each policy section
- Competency-based training and education materials. The major thrust of this component is directed at employees. Paper-based, web-based and face-to-face (PowerPoint presentation) training options were developed for this component. These training packages provide an overview of fatigue-related risk, responsibilities of management, and individual strategies to manage fatigue-related risk. In addition, a higher-level paper-based training package was developed for management and/or FRMS coordinators. This training package provides an overview of implementing an FRMS, and helps managers to understand, develop, implement, and evaluate each FRMS component.
- Audit methodologies that enable organizations to determine (a) the level of operational risk associated with fatigue; and (b) the location of the risk in time and the capacity to assess whether interventions have reduced the risk. These methodologies are cost appropriate for the level of risk managed by the organization.

As shown in Figure 1, the remainder of this document is split into three main sections: methodology for developing the toolbox, details of the toolbox, and conclusions.

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[2] McCulloch, K., Fletcher, A., & Dawson, D. (2003). *Moving towards a non-prescriptive approach to fatigue management in Australian aviation: A field validation.* Canberra, Australia: Civil Aviation Safety Authority.

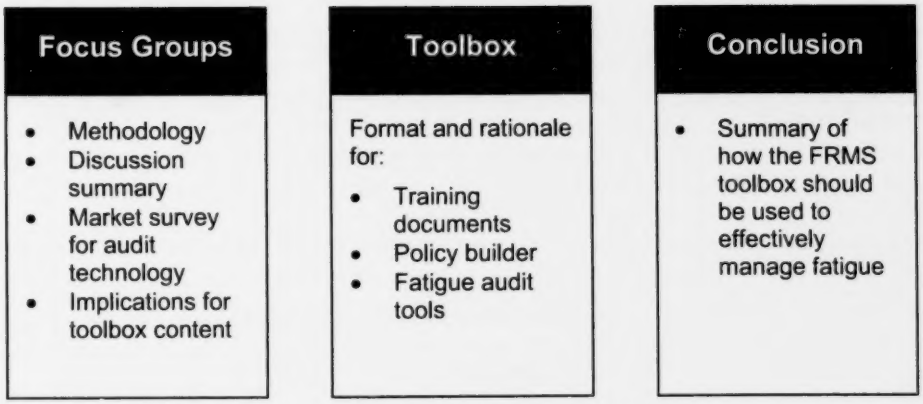

Figure 1: Report Structure

2. FOCUS GROUPS: FRMS TOOLBOX DEVELOPMENT

One of the most important aspects of any program design is its ability to meet the expectations and needs of end users. Therefore, the FRMS toolbox development process concentrated heavily on industry consultation in the form of focus groups with representative stakeholders.

2.1 Methodology

Thirteen aviation organizations across Canada agreed to participate in the focus groups. The organizations represented a broad cross section of industry, including small, medium and large operators. Various types of operations were consulted, including airlines, charters, and medevac (medical evacuation / air ambulance) and helicopter operations.

All organizations participating in the focus groups were contacted and scheduled for a suitable meeting time by a Transport Canada representative. Each organization was asked to nominate key stakeholders within the company who would be affected by an FRMS. Participation ranged from two to fourteen individuals per organization. Representatives included senior management, chief pilots, persons responsible for maintenance (PRMs), AMEs, pilots, schedulers, occupational health and safety representatives, human factors personnel, and union delegates. The focus groups were typically structured as a split-day session. That is, on the afternoon of the first day, focus group participants were presented with information about fatigue, fatigue management, and the specific components of the FRMS. The following morning, the participants returned for an open-ended discussion about each of the FRMS components and associated tools.

To facilitate discussion about fatigue, FRMS as a concept, and about the specific components, several broad questions were posed:

- In your opinion, is there a need to regulate fatigue in Canadian aviation? To what extent?
- What is your general opinion of the FRMS concept?
- What is your opinion of the way in which the proposed FRMS designs, evaluates, and records the fatigue risk associated with scheduling your employees' hours of work?
- What is your opinion of the individual-level scheduling/assessment system?
- Please comment on the policy templates and how they fit within the Canadian aviation environment.
- What level of training and education on fatigue risk management should be required as a minimum within the Canadian aviation environment?
- Would you prefer to design your own FRMS from scratch, or work from pre-approved templates?
- What other systems/factors should be considered in relation to the impact of an FRMS?

Focus group discussion notes were entered directly into a computer, and projected onto a whiteboard for participants to view and amend where necessary. Following each focus

group, the notes were reviewed and worked into paragraph format by the researcher. The text was then sent back to the participating organizations for final review before being included in the analysis. This process was performed to ensure accurate representation of each organization's opinions regarding the FRMS. One organization requested a minor change in the text, so that a negative statement about the FRMS reflected the views of an individual participant, rather than the group as a whole. All other organizations were content with the text and requested no changes.

All focus group transcripts were de-identified to protect the anonymity of participants. The individual focus group transcripts underwent content analysis to determine common trends of opinion and ideas between organizations.

2.2 Summary of Focus Group Discussion

The section summarizes the views of stakeholders who participated in the focus groups. They are not necessarily the views of Transport Canada or the researchers. The information discussed in this section is interpreted for application in the actual FRMS toolbox in section 3.

The general concepts behind the FRMS were well accepted by all focus group participants. In particular, participants believed the FRMS would:

- Increase operational flexibility
- Increase general awareness of the risks of fatigue
- Provide a sensible and flexible approach to fatigue risk management that is tailored to the organization's risk profile and scientifically defensible

Regarding the specific FRMS components, focus group participants thought it would be useful for Transport Canada to develop:

- Policy templates that clearly instruct which areas are relevant to tailor and examples of how to tailor to suit individual operations
- Organizational-level scheduling/assessment program
- Risk management guidelines for determining organizational-level scheduling benchmarks
- Individual-level scheduling/assessment systems
- Guidelines and decision trees for applying the individual level scheduling/assessment system
- Competency and web-based training and education

As evidenced by the focus group transcripts, the industry was supportive of the development of a public domain FRMS toolbox. Indeed, participants believed the provision of tools would significantly reduce the cost of FRMS development and implementation.

Many of the participants were concerned about the unnecessary imposition of additional bureaucracy to support the FRMS. To ensure that the management of fatigue-related risk is consistent with risk management in general, we suggest that the toolbox be

consistent with pre-existing Canadian Standards for Risk Management[3,4] and include a policy development tool that defines the issues that an operator should, and Transport Canada will, address in the development, implementation and review of an effective FRMS. It should also include policy templates for all pre-defined (off-the-shelf) FRMS plans and examples of other unique approaches developed by other operators. A significant proportion of focus group participants believed that a policy template would significantly reduce the cost of developing and approving an FRMS policy for both the operator and regulator. Policy templates would also provide the opportunity for industry associations to work on common positions and FRMS guidelines to shape industry practice over time.

Several focus group participants were concerned with the cost of developing and implementing the training and education required for an FRMS. This would be particularly true for small operators in remote areas, for whom there would be significant travel costs for trainers and for whom training costs would be amortized over a small number of employees. Consequently, it would be useful if a variety of training options were to be developed by Transport Canada, including traditional hard-copy and on-line (web-based) resources. Such an approach might keep the per-capita training costs at comparable levels across the industry.

Focus group participants also supported the development of tools and guidelines for the FRMS audit process. While audit software that is based on bio mathematical modelling has significant advantages for both operator and regulator, there are no clear guidelines on how it should be used or appropriate ways to set maximum fatigue risk levels. Transport Canada could play an essential role in facilitating the development of operational guidelines for appropriate use of schedule analysis tools.

It may also be appropriate for Transport Canada to support the introduction of simple audit tools that do not require a financial commitment from operators. Public domain audit models should be provided to ensure that small operators are not financially or operationally prohibited from developing appropriate audit technologies.

While the overall outlook at the conceptual level was positive, some concern was raised as to how the FRMS would work in reality when applied to industry. The negative feedback about any form of FRMS was largely related to concerns about how Transport Canada would develop and implement this project at the industry level and the workload associated with compliance. Major areas of concern included:

- Lack of existing examples of implementation. While the FRMS was well accepted at the conceptual level, operators expressed concern that there were few actual examples of how the FRMS worked within industry. Many individuals commented that they would like to see examples of FRMS in operation before it is either implemented on a global scale or incorporated into the Canadian Aviation Regulations (CARs). We believe that this concern could be alleviated by providing case studies of one or two FRMS forerunners in the Canadian aviation industry.

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[3] Canadian Standards Association (1991). CAN/CSA-Q634-91 *Risk Analysis Requirements and Guidelines, Quality Management – A National Standard of Canada*. Rexdale (Toronto).

[4] Canadian Standards Association (1997). CAN/CSA-Q850-97 *Risk Management: Guideline for Decision-Makers*. Rexdale (Toronto).

- The uncertainty of operational costs related to FRMS implementation. This was expressed in terms of ensuring a level playing field with other operators. That is, the expenditure and resources required for an FRMS had the potential to affect profitability and therefore competitive advantage. In particular, focus group participants were concerned that the system may flag areas of high fatigue risk in which a higher level of staffing would be required. Additional resources such as this, as well as the potential administrative burden of initial implementation, were seen as areas of concern.
- A final concern was raised regarding the ability of organizations to effectively manage the individual level scheduling/assessment system. Within the proposed system, individuals are required to monitor personal fitness for duty, using the amount of sleep they obtained in the prior 24 and 48 hours as a guide. Focus group participants recognized that in many instances, companies will require a significant change in organizational culture to bring employees to the point where they will be willing to operate under this system.

As a result of the feedback from the focus groups, the following actions were taken:

- Transport Canada has developed an FRMS toolbox that includes:
    - Effective FRMS policy development strategies, including clear descriptions of policy requirements, how to tailor the policy to meet specific operational needs, and examples of different FRMS policies
    - An organizational-level scheduling/assessment program (i.e. fatigue audit tools) that can be incorporated into current scheduling systems
    - Risk Management guidelines for determining organizational-level scheduling benchmarks
    - Individual-level scheduling/assessment systems
    - Guidelines and decision trees for applying the individual-level scheduling/assessment system
    - Competency and web-based training and education
- Following completion of the toolbox, Transport Canada will conduct a field study of the system with one operator to provide organizations with examples of how an FRMS will work in practice. The company selected for the pilot FRMS implementation will work closely with Transport Canada to determine and refine the necessary resources for effective FRMS implementation. This will be done from both the perspective of the regulator as well as various levels of industry. Following the field study, the FRMS tools should be evaluated and improved where necessary, based on the information gathered during the trial.

From a regulatory perspective, the pilot FRMS implementation will enable Transport Canada to closely monitor the progress of FRMS, observe how it was received by industry, and refine the system in the early stages before it is implemented on a wider scale. This will result in a more positive acceptance of the FRMS by industry and a smoother implementation process. From an industry perspective, this process will allow organizations to see the benefits of implementing an FRMS and gain insight from the lessons learned during the field study. Ultimately, field testing should minimize the cost and increasing the efficiency of FRMS implementation for both Transport Canada and the operator.

3. FRMS TOOLBOX COMPONENTS

Transport Canada's FRMS toolbox consists of three key components:

- FRMS training tools
- FRMS policy builder tool
- Fatigue audit tools

These will be available online from Transport Canada's website, www.tc.gc.ca.

3.1 FRMS Training Tools

Training and education are an essential part of an FRMS. They help to align the views, attitudes and beliefs of everyone in the organization to create an overall culture of safety. While the requirement to train and educate is unequivocal, organizations need a flexible approach to training, so they can choose training delivery methods to suit their needs. Furthermore, not all employees require a high-level knowledge of fatigue risk management, but simply the tools they can use as individuals to fulfil their responsibilities within the FRMS. Therefore, a number of different training levels have been provided as tools:

- *An Introduction to Managing Fatigue.* The introductory booklet contains very basic information about the nature of fatigue-related risk, and provides some personal strategies for fatigue risk management. This is intended as basic reading material for either newly hired employees in lieu of more comprehensive training, or for employees as an introduction to FRMS, to provide them with some information to be able to participate in the consultation process. Some organizations have found this level of information useful to send home to employees' families to help them understand the nature of fatigue-related risk and company requirements to ensure that employees have time for rest in their time away from work.

- *Fatigue Management Strategies for Employees.* This is the in-depth training that all employees who have responsibilities within the FRMS are required to complete. The training includes an overview of sleep and fatigue, causes of fatigue, and personal fatigue risk management strategies. Ideally, employees would first attend a workshop, during which they could interact and ask questions about fatigue and the organizational FRMS. The presentation and speakers' notes to deliver this workshop are included in the *Trainer's Handbook*. Following the workshop, employees should complete a personal training exercise and knowledge check to ensure they have understood and can apply all of the fatigue-risk management strategies learned throughout the training. This is provided as two options. The first is a *Fatigue Management Strategies for Employees* workbook that employees can read, and work through the activities as they go. The *Employee Training Assessment* guide provides training managers with appropriate answers to the exercises in the workbook.

  Alternatively, employees could work through similar information in a web-based training course. This course is structured into several modules, allowing employees to log in more than once and work at their own pace. Each module contains reading information about the specific topic, and is followed by a

number of activities. After completing all the module activities, employees complete a final assessment.

- *Developing and Implementing a Fatigue Risk Management System.* This is a guide specifically designed for those who will be responsible for designing, implementing, reviewing and/or managing the FRMS on a day-to-day basis. The training assumes that participants have already completed the *Fatigue Management Strategies for Employees* training component and have an understanding of basic fatigue concepts. The management training includes a background on the evolution and development of FRMSs, responsibilities and legal liabilities for fatigue risk management, core information on each of the FRMS components, audit and review processes and an implementation strategy.

3.2 Policy Builder Tool

For an FRMS to be effective, the policy and procedures on which it is based must be designed specifically to address operational risk. It is therefore essential that each organization develop their own FRMS policy document through consultation with its workforce.

The concept of having the flexibility to design operationally specific rules in the aviation industry is still relatively new. The aviation industry is used to having the rules handed down to them by the regulator. In the Australian general aviation FRMS trial, many operators found it difficult to design their own FRMS policy.[5] To provide some guidance, the Australian Civil Aviation Safety Authority released a sample FRMS policy for use by the industry. While the sample policy provided a good overview of what should be included in an FRMS, operators still found it difficult to tailor the policy content to their specific operation. As a result, the majority of operators simply pasted their names into the policy template and failed to consider many of the operationally specific FRMS components that should have been included.

While the focus group participants indicated that a policy template would be desirable, the lessons learned in the Australian FRMS trial were also taken into consideration. That is, while guidance for designing and implementing an FRMS policy is essential, a policy template may not be the best methodology. To overcome this problem, and to provide assistance to operators who choose to develop an FRMS, Transport Canada has developed a policy builder tool that provides a clear structure for the major components that should be included in an FRMS policy document. Within each element, information is provided at three different levels:

- Guidance Notes: an explanation of why the specific policy component is important, and how it fits within the overall FRMS.
- Points to Consider: specific questions to help tailor the policy component to an operation. The questions lend themselves particularly well to focus group consultation with employee representatives to structure and design the FRMS.
- Sample Text: an example of the type of text that could be included within each of the policy components. It is not intended that operators should copy this sample text. Rather, it provides an indication of the phraseology and content that is acceptable to Transport Canada.

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[5] McCulloch, et al., 2003.

If operators work through the policy builder tool, in consultation with the workforce, it is expected that the FRMS design should be relatively clear and well structured.

3.3 Fatigue Audit Tools

From an organizational responsibility perspective, one of the key components of developing an FRMS is ensuring that individuals are provided with sufficient sleep opportunity within their rostered shifts. Various methodologies of ensuring sufficient sleep opportunity for individual employees are outlined in *Introduction to Fatigue Audit Tools*, which provides readers with an understanding of good schedule design in line with fatigue risk management principles. It provides an overview of bio-mathematical fatigue modelling programs, a brief description of some of the existing programs, and a simple matrix to assess "fatigue likelihood" according to scheduled hours of work.

3.3.1 System-wide Evaluation

As a part of the initial contract between Transport Canada and edu.au, a FAID[6] roster analysis was to have been conducted with a number of aviation operators throughout Canada to determine the level of fatigue likelihood within existing operations. Unfortunately, very few operators provided records of actual employee work hours for analysis. We were therefore unable to complete this deliverable.

[6] Fatigue Audit InterDyne (FAID) is a fatigue modelling software for analyzing work schedules.

4. CONCLUSION AND RECOMMENDATIONS

The reality of fatigue-related risk is clearly recognized by the Canadian aviation industry. Based on the interviews in this study, it would appear that the industry is prepared to work collaboratively with Transport Canada to better manage fatigue-related risk, but believes that significant assistance from Transport Canada will be required to do this effectively. In response to industry concerns raised during the consultation process, Transport Canada has developed a set of fatigue risk management tools that can be used by the industry for designing, implementing and evaluating an FRMS on a day-to-day basis. That said, we believe there are several additional issues that should be considered.

- One of the greatest stumbling blocks for any regulatory initiative is a lack of preparedness on behalf of the inspectorate. Before the FRMS is rolled out across the industry, local inspectors should be trained and educated in the principles and practice of FRMS. They should be skilled in assessing FRMS proposals for entry control and recommendation to central offices, as well as conducting annual audits. Ideally, the training, which should take approximately three to four days, would be interactive and cover the following topics:
    - History of fatigue risk management
    - Background on sleep, wakefulness and fatigue
    - Consequences of fatigue-related error and legal liabilities and responsibilities
    - Overview of FRMS
    - FRMS components and practical application
    - FRMS entry control procedures – how to assess an FRMS application
    - FRMS compliance audits
    - Workshop – assess existing FRMS policies (good and bad examples)
    - Workshop – write sections of an FRMS policy
- A wide-scale FRMS implementation should be coupled with comprehensive FRMS evaluation procedures and protocols. The FRMS should be seen as an evolving system that will constantly improve as the industry gains more experience, and a greater level of knowledge is shared within the industry. Transport Canada should conduct a large-scale evaluation within two years of wide-scale FRMS implementation and every five years thereafter.
- The regulator should work closely with the industry throughout the FRMS trial and wide-scale implementation. Information about lessons learned should be continually fed back to the industry. This would best be achieved through regulatory safety bulletins or website links. Ideally, industry experiences would be written up into case studies of what worked and what did not work. This level of information sharing should expedite the cultural change that is required for industry to embrace effective fatigue risk management practices.
- The issue of maintaining a level playing field should be addressed by establishing standard practices in the initial stages of FRMS implementation. An effective way of achieving this is to control the assessment of the first few trial FRMS implementations from a centralized unit within Transport Canada. Once

the standards of assessment are established, the assessment and approval procedures can then be moved to the regional inspectors.

From a regulatory perspective, maintaining centralized control over the first few organizations to implement an FRMS will help to ensure consistency across the industry. This process will allow Transport Canada to ensure that the appropriate resources and knowledge are in place in terms of assessment procedures across different operational sites. Once this has been achieved, Transport Canada can train regional inspectors to ensure they are sufficiently skilled to perform assessments in a manner consistent with the broader concept of safety management systems.

- It is acknowledged that a significant culture change is required in many instances for several FRMS components, particularly at the individual level of responsibility. Therefore, it is recommended that the FRMS be implemented progressively to ensure that sufficient time is provided for training and education to occur at various levels of industry. It is also recommended that an industry-specific set of applied FRMS workshop scenarios be designed. These would help to ensure that individuals – both managers and employees – realize and understand the practical implications and liabilities of FRMS.

  Ultimately, providing a generous amount of time for FRMS implementation would enable industry to slowly introduce the concept of fatigue management to employees, leading to the necessary attitudinal change in personal responsibility obligations. This would greatly enhance the acceptability and operational application of FRMS on a larger scale. From a regulatory perspective, it would also allow Transport Canada to ensure that the appropriate resources were in place to assess and accept the FRMS applications.

- Finally, fatigue risk management is becoming common practice throughout the industrialized world. Transport Canada should collaborate with other regulators throughout the world who are undertaking similar trials to share implementation and best-practice experiences.